

CEMP-RT

**DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000**

EM 200-1-5

Manual
No. 200-1-5

1 October 1997

**Environmental Quality
DESIGN, INSTALLATION AND UTILIZATION OF
FIXED-FENCELINE SAMPLE COLLECTION
AND MONITORING SYSTEMS**

Table of Contents

Subject	Paragraph	Page
Chapter 1		
Introduction		
Purpose	1-1	1-1
Applicability	1-2	1-1
References	1-3	1-1
Scope	1-4	1-1
Overview of Manual	1-5	1-2
Chapter 2		
How to Use This Manual		
Introduction	2-1	2-1
Defining Monitoring Program Objectives, Intended Use of Data, and Data Quality Objectives	2-2	2-1
Preparing Planning and Execution Documents	2-3	2-3
Site Set-Up and Operation	2-4	2-5
Operation and Maintenance of Equipment	2-5	2-5
Data Analysis and Reporting	2-6	2-5
Chapter 3		
Monitoring Objectives and Technological Options		
Introduction	3-1	3-2
Data Quality Objectives (DQOs)	3-2	3-2
Regulatory Limits, Action Levels, and Site Specific Alert Levels and Triggering Mechanism	3-3	3-10
EPA's Air Pathway Analysis (APA) Mechanism	3-4	3-17
Chemical and Physical Properties of Hazardous Air Pollutants (HAP)	3-5	3-21
Technical Consideration in the Development of a Fixed-Fenceline Sample Collection and Monitoring System.	3-6	3-39
Chapter 4		
Function of the Analytical Center		
Introduction	4-1	4-2
Analytical Center System Components	4-2	4-2

EM 200-1-5

1 Oct 97

Analytical Systems and Options	4-3	4-9
Supporting Measuring Methods	4-4	4-34

Table of Contents (cont.)

Subject	Paragraph	Page
---------------	-----------	------

System Alarm Configuration	4-5	4-61
----------------------------------	-----	------

Chapter 5

Requirements for the Collection System

Introduction	5-1	5-2
System Design, Structure, and Components	5-2	5-2
Sampling System Inlet Particulate Control	5-3	5-3
Sample Transport Requirements	5-4	5-9
Sample Conditioning System	5-5	5-23
Routine Maintenance and Corrective Action Requirements	5-6	5-25
Time-Integrated and Real-Time PM ₁₀ Monitoring Requirements for Collection System	5-7	5-28
Verification of the Sample Collection System	5-8	5-42

Chapter 6

Meteorological Monitoring System

Introduction	6-1	6-2
Meteorological Monitoring System and Organization	6-2	6-2
Integration of Analytical System and Sample Collection System with Meteorological Monitoring	6-3	6-23
Meteorological Monitoring and Perimeter Action Levels	6-4	6-24

Chapter 7

Data Management System

Introduction	7-1	7-2
Data Acquisition System Design, Operation, and Users	7-2	7-2
Data Compilation, Storage, Transmission, and Reporting	7-3	7-5

Chapter 8

Quality Assurance/Quality Control Requirements

Introduction	8-1	8-2
Quality Planning	8-2	8-2
Characterizing Data Quality	8-3	8-9
QA/QC Applications to FFMS Programs	8-4	8-12
Generation of Standard Test Atmospheres	8-5	8-19
Reference Methods Requirements for Calculating System Accuracy	8-6	8-27
Corrective Action Requirements	8-7	8-30

Table of Contents (cont.)

Subject

Appendices

Appendix A
References

Appendix B
Acronyms and Definitions

Appendix C
Guidelines for Developing Standard Operating Procedures (SOPs) for
Fenceline Monitoring

Appendix D
National Technical Guidance Series, Bulletin Boards, and
Electronic Data Bases

Appendix E
Conversion Factors for Common Air Pollution
Measurements and Other Useful Information for HTRW Sites

Appendix F
Manufacturers of Sampling and Analytical Equipment

Appendix G
Development of a Target Compound List (TCL)

List of Tables

<u>Table</u>		<u>Page</u>
Table 2-1	Relevance Of Manual Chapters To Project Planning And Execution Steps	2-4
Table 3-1	Defining Hazardous Air Pollutants	3-23
Table 3-2	Example Of Classification Of Organic And Inorganic Compounds For Air Monitoring At HTRW Sites	3-30
Table 3-3	Example of Typical Concentrations of HAPs in the Atmosphere	3-32
Table 3-4	Relationship Between Ambient Air Monitoring Design Elements and the Three Phases of Remediation at a HTRW Site	3-33
Table 3-5	Example of Components of the RIA Program for a HTRW Site	3-34
Table 3-6	Example Of RIA And Deviation Of Term Values RIA = 10G + 11.3B + 120M + 7.5D + 23.3F + 10K + 20L + 40E + 35C + 15J	3-37
Table 3-7	Example of Sample Calculation For Vinyl Chloride	3-38
Table 3-8	Example of Compilation Of Analytes Of Interest As Part Of The Selection Process at a HTRW Site	3-49
Table 3-9	Example of Three (3) Site Specific Target Compounds Selected from Table 3-8 as Results From the Selection Process	3-49
Table 3-10	Example of Summary of Key Probe Siting Criteria for FFMS Program	3-54
Table 3-11	Example of Cost Associated With a Real-Time Volatiles FFMS Program For Five (5) Years as Documented by the Corp's HTRW Remedial Action Work Breakdown Structure (RA WBS) . . .	3-58
Table 3-12	Example of Checklist Associated With Certification of Manufacturer's Guarantees Associated With a FFMS Program	3-62
Table 4-1	Example Analytical Center Staffing/Schedule For Continuous Operation	4-9
Table 4-2	Analytical Center Checklist For Continuous Operation	4-10
Table 4-3	Example of Analytical Center Preventive Maintenance Program For Continuous Operation	4-15
Table 4-4	Example of Commonly Used GC Detectors	4-22
Table 4-5	Electron Capture Detector Relative Response Factors (Benzene = 1)	4-24
Table 4-6	Photoionization Potential Of Several Organic Compounds	4-25
Table 4-7	Sensitivity Of Organic Compounds Relative To Benzene On A Molar Basis (Benzene = 1.0) for the PID	4-25
Table 4-8	Example Characteristics Of Various Common Detectors Used as Part of FFMSs at HTRW Sites	4-30
Table 4-9	Examples of Useful GC Detector Combinations	4-31
Table 4-10	Example of Common GC Detectors, Detection Limits, And Advantages/limitations	4-31
Table 4-11	Criteria Pollutants and Their Reference Methods	4-36
Table 4-12	Brief Method Description and Applicability for Organic and Inorganic Compendia	4-39
Table 4-13	Advantages/Disadvantages Associated with Sampling Methods Presented in Inorganic Compendium Method IO-1	4-56
Table 4-14	Advantages/Disadvantages Associated with Analytical Options Discussed in Inorganic Compendium Chapter IO-3	4-57
Table 4-15	Minimum Detection Limits (ng/m ³) of Ambient Air Samples For Different Inorganic Compendium Chapter IO-3 Analytical Methods ^a	4-60
Table 5-1	Example of Subsystems of the Collection system of a Real-time VOC FFMS	5-3
Table 5-2	Example of Sampling Line Lag Time For Various Dimensions	5-16
Table 5-3	Maximum Continuous Operating Temperatures for Heat Trace Lines Materials of Construction . . .	5-18
Table 5-4	Example Cost of Various Sample Line Materials Based on 100 ft of 6.35 mm OD Tubing	5-19
Table 5-5	Subdivisions of Positive Displacement Pumps	5-21
Table 5-6	Example of Advantages/Disadvantages of Air Moving Systems	5-23
Table 5-7	Example of Routine Maintenance and Corrective Action for a Sample Collective System	5-26

Table 5-8	Example of Types of Filter Media for Particulate Sampling	5-33
List of Tables (cont.)		

<u>Table</u>	<u>Page</u>
Table 5-9	Example of Advantages/Disadvantages of Particulate Sampling Methods 5-39
Table 5-10	Example of Typical Collection System Audit Parameters 5-43
Table 6-1	Example of Key Siting Criteria for Meteorological Stations at HTRW sites 6-3
Table 6-2	Example of System Accuracy and Measurement Resolution for Meteorological Systems at HTRW sites 6-4
Table 6-3	Example of Use of Solar Radiation/Delta-T (SRDT) Method for Estimating Pasquill-Stability Categories 6-9
Table 6-4	Standard Certification Instrumentation for Meteorological Station Audits 6-15
Table 6-5	Suggested Data Screening Criteria for a Meteorological System at a HTRW Site 6-21
Table 7-1	Example of Applicable Levels of Data Validation for Real-Time and Collocated Time-Integrated Methods 7-11
Table 8-1	Example Data Quality Indicators and Specifications for a FFMS Program at a HTRW Site 8-13
Table 8-2	Example of QC Checks Associated with HTRW FFMS Program 8-14
Table 8-3	Example of HTRW FFMS Program Performance Audits 8-15
Table 8-4	Example of Criteria and Data Qualifier Limits for a FFMS Involving Real-Time, Perimeter Air Monitoring 8-15
Table 8-5	Example of Typical Routine/Preventative Maintenance Activities Associated with HTRW FFMS Program at a HTRW Site 8-18
Table 8-6	Volatile Organics that are Stable for 6 Months in Gas Cylinders at the 50 ppb Level 8-23
Table 8-7	Gas Standards Tolerances 8-23

List of Figures

<u>Figure</u>		<u>Page</u>
Figure 2-1.	Project planning and execution steps	2-2
Figure 2-2.	Relationship between design requirements and support elements of the FFMS.	2-3
Figure 3-1(a).	Seven steps associated with EPA's DQO process.	3-4
Figure 3-1(b).	Seven steps associated with the DQO process as applied to air monitoring at HTRW sites.	3-4
Figure 3-2.	Example levels of response for short-term action levels at HTRW sites	3-13
Figure 3-3.	Example of site-specific alert levels involving NMOC and speciated organics, associated with an FFMS at HTRW sites	3-14
Figure 3-4.	Example of decision for alarm level 1, NMOC mode	3-15
Figure 3-5.	Example of decision for alarm levels 2, 3, and 4, speciated mode.	3-16
Figure 3-6.	Example of EPA's air pathway analysis mechanism	3-18
Figure 3-7.	Example of EPA's defining hazardous air pollutants by boiling point.	3-24
Figure 3-8.	Example of flowchart for defining a site specific target compound list at a HTRW site.	3-40
Figure 3-9.	An example of sampling program objectives for a HTRW site assessment study	3-44
Figure 3-10.	Example of application of monitoring NMOC/speciated organics at the site perimeter as part of the selection process.	3-50
Figure 3-11.	Example of a 12-point monitoring network HTRW site	3-52
Figure 3-12.	Example of a 4-point monitoring network with inlet probes at	3-53
Figure 3-13.	HTRW remedial action work breakdown structure (RAWBS)	3-57
Figure 3-14.	Example of a program timeline for establishing a real-time volatile FFMS at a HTRW site	3-63
Figure 3-15.	Example of contractor organization chart showing relationship of quality assurance to other organizational functions for a real-time volatile FFMS	3-64
Figure 4-1.	Example Analytical Center system components	4-3
Figure 4-2.	Example of a typical Analytical Center at a HTRW.	4-4
Figure 4-3.	Inside of Analytical Center at a HTRW Site as Part of a FFMS	4-7
Figure 4-4.	GC detector comparison associated with method detection limits	4-30
Figure 4-5.	Example of schematic for NMOC decision mode.	4-32
Figure 4-6.	Example of schematic for speciated decision mode	4-32
Figure 4-7.	Schematic of net concentration decision mode	4-33
Figure 4-8.	Schematic of real-time gas chromatograph system with NMOC "RAM" and speciation VOC modes (functions)	4-34
Figure 4-9.	Example of a commercially available multi-port NMOC/analytical gas chromatographic system for HTRW applications	4-35
Figure 4-10.	Compendium of organic methods for sampling and analysis of HAPs at HTRW sites	4-38
Figure 4-11.	Compendium of inorganic methods for sampling and analysis of HAPs at HTRW sites	4-38
Figure 4-12.	Compendium Method TO-1 Analytical Scheme	4-41
Figure 4-13.	Compendium Method TO-3 Sampling and Analytical Methodology	4-42
Figure 4-14.	Compendium Method TO-9A Sampler for Dioxins/Furans	4-43
Figure 4-15.	Example of TO-9A adsorbent cartridge used for capturing dioxins/furans	4-43
Figure 4-16.	Compendium Method TO-14A sampling system using pressurized treated stainless steel canister(s)	4-44
Figure 4-17.	Compendium Method TO-14A analytical scheme	4-48
Figure 4-18.	Example of a PM ₁₀ Sampling Decision Tree for HTRW sites.	4-54
Figure 4-19.	Relationship between sampling technologies and analytical techniques discussed in EPA's Inorganic Compendium.	4-58
Figure 4-20.	Typical detection limits for Inorganic Compendium Chapter IO-3 analytical options	4-59
Figure 4-21.	Throughput of analytical options in Chapter IO3	4-62
Figure 5-1.	Example components of the sample collection system for FFMS	5-2

Figure 5-2.	Typical inlet configuration of a perimeter volatile organic sampling system	5-3
List of Figures (cont.)		

Figure		Page
Figure 5-3.	Example of heat-trace line layed above ground as part of perimeter volatile organic sampling system	5-4
Figure 5-4.	Example of sintered stainless steel inlet filter as part of a perimeter VOC FFMS	5-5
Figure 5-5.	Example of probe inlet design with intake funnel and heated sintered stainless steel filter for particulate matter control	5-5
Figure 5-6.	Composite of a FFMS inlet design for extracting samples for VOC analysis	5-6
Figure 5-7.	Example of field application of an inlet configuration for an extractive perimeter VOC FFMS	5-6
Figure 5-8.	Example of an inertial filtration system as a particulate matter control device on an extractive VOC FFMS	5-7
Figure 5-9.	Example of properly placed extractive perimeter VOC inlet probe collocated with RMM time-integrated monitoring systems	5-9
Figure 5-10.	Example of a complete heat-trace line assembly containing PTFE Teflon® as part of an extractive VOC FFMS	5-12
Figure 5-11.	Example of up to 1,000 feet per sample point of heat-trace lines extends from Analytical Center to specific inlet probe locations around perimeter of HTRW site	5-12
Figure 5-12.	Example of nominal 200-foot heat-trace line segments connected to Analytical Center using J-Boxes around perimeter of HTRW site	5-13
Figure 5-13.	Example of components of a typical J-Box used to connect nominal 200 foot lengths of heat-trace lines	5-14
Figure 5-14.	Actual on-site connection of two heat-trace lines using a J-box as part of a FFMS	5-15
Figure 5-15.	Example of flow rates vs. pressure drop for various sample lines sizes	5-15
Figure 5-16.	Example of temperature vs. system pressure to maintain water in the vapor state	5-17
Figure 5-17.	Example of encapsulated heat-trace line in PVC conduit around the perimeter of a HTRW site	5-20
Figure 5-18.	Example of encapsulated above-surface heat-trace lines entering sub-surface location around the perimeter of a HTRW site	5-20
Figure 5-19.	Example of the operation of a diaphragm pump used as part of a FFMS at a HTRW site	5-21
Figure 5-20.	Example of an air driven eductor used as part of a FFMS at a HTRW site	5-22
Figure 5-21.	Example of a perma-pure dryer used as part of a FFMS at a HTRW site	5-25
Figure 5-22.	Example of equipment maintenance/repair report as part of a FFMS program	5-27
Figure 5-23.	Example of a corrective action report as part of a FFMS program	5-29
Figure 5-24.	Example of application of a RMM for time-integrated TSP monitoring collocated with sample inlet probe for a FFMS for volatile organics around the perimeter of a HTRW site	5-30
Figure 5-25.	Example of (a) TSP sampler and (b) PM ₁₀ sampler	5-31
Figure 5-26.	Example of PM ₁₀ dichotomous sampler (a) and inlet head (b)	5-32
Figure 5-27.	Example of operation of a typical commercial PM ₁₀ beta-gauge sampler	5-36
Figure 5-28.	Example of a real-time PM ₁₀ sampler based upon the oscillating microbalance (TEOM®) technique	5-38
Figure 5-29.	Depiction of maximum and minimum number of recommended monitoring locations for a typical HTRW site	5-40
Figure 5-30.	Example of a diagram of a collocated TSP and VOC inlet samplers	5-41
Figure 5-31.	Example of QC procedures for evaluating transfer efficiency and flow rate of a FFMS	5-44
Figure 6-1.	Example of a 10-meter meteorological station at a HTRW site	6-5
Figure 6-2.	Example of daily meteorological report for a HTRW site	6-12
Figure 6-3.	Example of typical meteorological display (wind rose) of wind speed and direction	6-13
Figure 6-4.	Example of meteorological report illustrating daily two parameter graph for a HTRW site, Any Town, USA	6-14

EM 200-1-5
1 Oct 1997

Figure 6-5.	Example of meteorological report illustrating 5 day single parameter (wind speed) graph for a HTRW site, Any Town, USA	6-16
Figure 6-6.	Example of corrective action report for a HTRW site meteorological program	6-17

List of Figures (cont.)

<u>Figure</u>		<u>Page</u>
Figure 6-7.	Example of request for corrective action report for a HTRW site meteorological program	6-18
Figure 6-8.	Example of site calibration report for a HTRW site meteorological program	6-19
Figure 6-9.	Example of site inspection form for a HTRW site meteorological program	6-20
Figure 6-10.	Example of EPA's three stage meteorological data processing, MPRM Version 1.2	6-22
Figure 6-11.	Example of connecting the HTRW site meteorological station with the sample collection system and the DAS in the Analytical Center.	6-24
Figure 6-12.	Example of HTRW site divided into 90° quadrants for calculating upwind/downwind net concentration of site specific target analytes	6-26
Figure 7-1.	Example of data acquisition, storage, and reporting configuration, for a FFMS at a HTRW site. . .	7-3
Figure 7-2.	Example of HTRW DAS network configuration in the Analytical Center.	7-4
Figure 7-3.	Example of data file transmission and storage as part of a HTRW DAS.	7-6
Figure 7-4.	Example of data file formats.	7-7
Figure 7-5.	Example of data recovery report from DAS in Analytical Center.	7-8
Figure 7-6.	Example of single-parameter 24 hour report from DAS in Analytical Center.	7-9
Figure 7-7.	Example of levels of data validation recommended by EPA.	7-10
Figure 8-1.	Example of essential elements of quality planning as part of a HTRW FFMS.	8-4
Figure 8-2.	Example of required elements of a quality assurance project plan (QAPP) for a HTRW FFMS.	8-5
Figure 8-3.	Example of a QAPP review and approval checklist from EM 200-1-3.	8-6
Figure 8-4.	Example of four types of quality assurance audits associated with a FFMS at a HTRW site	8-7
Figure 8-5.	Example of typical QC samples associated with a FFMS.	8-8
Figure 8-6.	Example of maintenance/repair report form as part of a HTRW FFMS program.	8-17
Figure 8-7.	Example of gas dilution system using a single gas cylinder diluted with zero air as part of a HTRW FFMS program.	8-25
Figure 8-8.	Example of collocated time-integrated RMM (TSP and VOC) with perimeter real-time, on-line monitors at a HTRW site	8-29
Figure 8-9.	Utilization of RMM, Compendium Method TO-14, in calculating percent accuracy as a collocated unit at the perimeter of a HTRW site.	8-31
Figure 8-10.	Example of corrective action report form as part of a FFMS at a HTRW site.	8-32